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United States
Environmental Protection
Agency

Industrial Environmental Research
Laboratory
Cincinnati OH 45268

Research and Development

EPA-600/S3-81-079 July 1981

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Project Summary

SEP 25 1981

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Evaluation of the Walkthrough Survey Method for Detection of Volatile Organic Compound Leaks

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During 1978 and 1979 the Emission Standards and Engineering Division of EPA's Office of Air Quality Planning and Standards conducted a fugitive volatile organic compound (VOC) emission sampling program in organic chemical manufacturing plants and petroleum refineries. As a part of their sampling program, several "walkthrough surveys," also called "unit area surveys," were conducted. The assistance of EPA's Industrial Environmental Research Laboratory-Cincinnati was requested in the analysis of the walkthrough survey data.

Fourteen walkthrough surveys were analyzed, from four plants. The analysis reported here focuses on the variability and reproducibility of the survey method. One indicator of variability which was studied was the coefficient of variation (CV). The CV's ranged from 55% to 408%, for each pair of walkthrough surveys. Further, the linear correlation coefficients for each set of surveys ranged from 0.046 to 0.98. No attempt was made to evaluate the sources of the variability.

This Project Summary was developed by EPA's Industrial Environmental Research Laboratory, Cincinnati, OH, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

During 1978 and 1979, the Emission Standards and Engineering Division of EPA's Office of Air Quality Planning and Standards conducted a fugitive volatile organic compound (VOC) emission sampling program in organic chemical manufacturing plants and petroleum refineries. The data were used in the development of background information documents for regulations to control VOC emissions resulting from leaks in process equipment. As a part of this sampling program, several "walkthrough surveys," also called "unit area surveys," were conducted. A unit area survey involves measuring the ambient VOC concentration within approximately 1 meter of all ground level equipment within a processing area. These measurements are performed with a portable VOC detection instrument utilizing a strip chart recorder. An elevated reading on the strip chart is assumed to be indicative of a leak. Each individual piece of equipment located in the area where the elevated VOC concentration was found is then checked to determine the sources of the VOC emissions.

The purpose of the walkthrough surveys conducted by EPA was to determine if this approach represents a

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viable technique for the detection of leaks, within a regulatory context. The assistance of EPA's Industrial Environmental Research Laboratory in Cincinnati was requested in the analysis of the walkthrough survey data. The purpose of this report is to document the techniques of data analysis and to present the results. Fourteen walkthrough surveys were analyzed, from four plants. The analysis reported here focuses on the variabilitiy and reproducibility of repeated surveys, and does not attempt to correlate ambient VOC concentrations with specifically located VOC sources.

The walkthrough surveys were conducted at four plants: two chloromethane units, one ethylene unit, and a benzene-toluene-xylene (BTX) unit. The instrument used in all cases was the Century Systems Corporation Organic Vapor Analyzer (OVA), Model 108, which was equipped with a strip chart recorder. The instrument measures organic vapor concentrations in ppmv. For each unit or section of a unit, a walkthrough path was developed. This path was intended to pass within a meter of major pieces of equipment at ground level, e.g., pump rows, compressors. Two surveys were conducted sequentially, usually within a few minutes of each other.

Conclusions

As stated before, the data analysis focused on the variability and reproducibility of the measurement technique. Therefore, both the coefficient of variation (CV) and the linear correlation coefficients (R) were evaluated, for each pair of walkthrough surveys (i.e., the sequential surveys for each path). First, however, a technique was developed to facilitate direct comparison of the two chart recordings.

The first step was to trace a continuous curve through the discontinuous marks made on the strip chart by the OVA recorder. The "smooth" curve on the strip chart was then divided into cells which contained the location designations A, B, C, etc. This was done by finding the midpoints of the interval between two locations, e.g., B to C, and C to D. These two midpoints, then, form the cell boundary for the cell which contains "C." These are shown in the charts as long, darker horizontal lines. Once the cells were identified, the maximum value for each cell was read directly from the chart. Although the actual units are unimportant for the analysis reported here, the instrument read-out is in ppmv. It should be noted that the charts have a logarithmic scale.

The charts for a pair of walkthroughs have been designated as Survey A and Survey B according to the order in which they were executed. The mean difference between Survey A and Survey B was studied as one indicator of variability. The absolute value of the difference was used since only the magnitude of the difference is important, and not the fact that values from Survey A are higher (or lower) than Survey B.

The following statistics were calculated for each pair of walkthrough surveys:

$\bar{x}$ = mean difference = $\frac{\sum^{n}|(A-B)|}{n}$

s = standard deviation of the mean difference

CV = coefficient of variation = $\frac{s}{\bar{x}} \times 100$

R = linear correlation coefficient (between the Survey A and Survey B values)

The coefficient of variation provides one way to evaluate the variability of data sets which have widely varying means. Because the means observed were widely different, a simple analysis of the standard deviations for each walkthrough survey may not yield meaningful results. To reduce the effect of the differing means, the coefficient of variation was selected.

The CV's ranged from 85% to 408%. Further there does not appear to be any trend relative to plant or type of production facility.

The sample linear correlation coefficients ranged from 0.046 to 0.98. A value near 1 indicates a strong linear relationship in which the value from Survey B increases when the value from Survey A increases. A value of R close to zero results from data that display a strictly random effect, which implies little or no relationship. However, since R is a measure of the linear relationship, a value of R near zero really implies a lack of linearity and not necessarily a lack of association.

Recommendations

Based on the results reported here, it appears that the walkthrough survey technique is highly variable and is not reproducible in many cases, even when repeated within minutes. In several instances, there is essentially no correlation between the pair of surveys, as indicated both by the linear correlation coefficients (R) and by plots of the data. Thus, there is no indication that the walkthrough survey method can be used as the basis of a leak detection program for regulatory purposes. To be used for such purposes a maximum local ambient VOC concentration which triggers remedial action would have to be established. This analysis shows that on repeated surveys a local concentration is usually not repeated on two passes by the same location, nor are the concentrations linearly proportional.

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***Robert C. Weber** is the EPA Project Officer (see below).*
The complete report, entitled "Evaluation of the Walkthrough Survey Method for Detection of Volatile Organic Compound Leaks," (Order No. PB 81-199 382; Cost: $8.00, subject to change) will be available only from:
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• U.S. GOVERNMENT PRINTING OFFICE: 1981 -757-012/7221

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